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(71) Applicant: HENKEL CORPORATION [US/US]; Suite 200, 2500 Renaissance Boulevard, Gulph Mills, PA 19406 (US).

(72) Inventor: WYCECH, Joseph, S.; 927 Lakeshore Road, Grosse Pointe Shores, MI 48236 (US).

(74) Agent: HARPER, Stephen, D.; Henkel Corporation, Suite 200, 2500 Renaissance Boulevard, Gulph Mills, PA 19406 (US).

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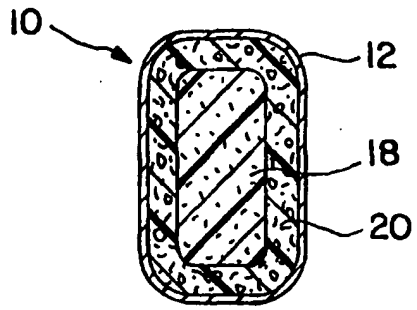
(54) Title: THREE DIMENSIONAL LAMINATE BEAM STRUCTURE




(57) Abstract

A three–dimensional laminate beam (10) is formed by inserting a preformed foam core (18) insert within a hydra–formed metal section (12) having curved three–dimensional geometry. A reinforcing polymer (20) is pumped in and around the foam core insert so as to be adjacent the inside wall of the shell. The polymer bonds to the inside wall of the shell upon the polymer being cured.

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# THREE DIMENSIONAL LAMINATE BEAM STRUCTURE

## BACKGROUND OF THE INVENTION

For various applications, such as in the automotive industry, it is desirable to reinforce a structural section. One approach has been to use a polymer structural foam material for such reinforcement. In some of these applications, however, because of the location or geometry of the part being reinforced, it is difficult to accomplish the intended reinforcement.

Hydra-formed metal sections, for example, may have curved three-dimensional geometry. As a result, reinforcing the section or component is very difficult because the location of the hydra-formed section that is critical and decides the overall performance of the component, is often the section located at a major discontinuity "notch" or curvature.

## SUMMARY OF THE INVENTION

An object of this invention is to provide a reinforced beam of curved geometry.

A further object of this invention is to provide techniques for reinforcing such a beam.

In accordance with this invention the beam is a hollow structure. A pre-molded foam core is inserted into the hollow structure spaced from at least one inside wall of the hollow structure. A polymer is pumped in and around the foam

core insert so that after curing the polymer bonds to the inside wall of the structure.

In a preferred practice of the invention the structure is a hydra-formed metal section, such as a vehicle control arm assembly. The pre-shaped foam insert is preferably made of a lightweight material to minimize the weight of the final laminate beam formed by the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a perspective view of a laminated control arm assembly beam in accordance with this invention; and

Figure 2 is a cross-sectional view taken through Figure 1 along the line 2-2.

**DETAILED DESCRIPTION OF THE INVENTION**

The present invention is particularly useful for reinforcing hollow sections or structures, which are of curved geometry and/or located at locations, which are relatively inaccessible.

In the preferred practice of the invention the hollow structure is a metal section, such as a hydra-formed metal section with curved three-dimensional geometry. An example of such section is a control arm assembly, wherein it is desired to reinforce the control arm beam. For such hydra-formed section the critical portion which requires reinforcement in order to maximize the overall performance of the component is often the portion at a major section discontinuity "notch" or curvature. Figure 1, for example,

illustrates an automotive control arm assembly beam 10 made of a hydra-formed metal shell 12 of conventional size and shape and structure such as including through holes 14 and end walls 16. As can be seen the shell 12 has a three dimensional geometry which is non-uniform from end wall to end wall and which is curved.

Because of its geometry, it is very difficult to reinforce a control arm beam 10 by conventional practices. In accordance with this invention a preformed foam core 18 is inserted into the hollow or cavity of shell 12. Core 18 is spaced away from at least one inside wall of the hollow shell 12 and is shaped to extend along at least one side of the shell. Core 18 functions to locate a reinforcing polymer 20 within the hollow shell so that after curing the polymer will bond to and reinforce the inside wall of the shell.

Core or insert 18 is made of a lightweight pre-shaped or preformed material such as urethane, phenolic or expanded polystyrene. The polymer 20 would be pumped in and around the foam core 18 so as to be located in the space between core insert 18 and the inner wall of shell 12. Polymer 20 is then cured such as being heat cured or ambient temperature cured. Upon curing polymer 20 is bonded to the inner wall of shell 12 and to foam core 18 to function as a structural foam. The polymer or structural foam may be, but is not necessarily an expandable foam.

Examples of suitable foam material are found in my U.S. Patent No. 5,575,526 and in co-pending application Serial No.

09/103,031 filed June 23, 1998, all of the details of that patent and application are incorporated herein by reference thereto.

The curing of the polymer could be accomplished in any suitable manner. For example, where the shell 12 is a vehicle component, the polymer could be heat cured in an oven such as an e-coat oven during the manufacturing of the vehicle. Alternatively, the polymer could be cured at ambient temperatures such as, for example, about 77°F.

The foam core insert 18 may be pre-shaped in a geometry which generally conforms to the inner surface of shell 12 thereby minimizing the amount of polymer material required to fill the remaining open space within shell 12. Alternatively, core insert 18 may be of uniform cross-sectional shape throughout all or most of its length to simplify the structure of the core insert, but which would result in a greater amount of open space. The foam core insert 18 thus comprises a three-dimensional or essentially two dimensional molded pre-formed part which occupies some of the volume or space within shell 12 and provides a substrate for the polymer 20 which is pumped into the shell 12.

The invention thus results in a three-dimensional laminate beam, which is formed by pumping the polymer around the pre-molded foam core. This is the only means necessary to reinforce such a hydra-formed metal section.

**IN THE CLAIMS:**

1. A three dimensional laminate beam structure comprising an outer shell having inside walls and an open space between said walls, at least a portion of said shell being curved, a core insert mounted within said shell spaced from at least one of said inside walls, a reinforcing polymer within said shell, and said polymer being disposed against said core insert and bonded to said inside wall of said shell.

2. The beam of claim 1 wherein said core insert is made of a lightweight foam.

3. The beam of claim 2 wherein said polymer is pumped in and around said foam core insert.

4. The beam of claim 3 wherein said shell is made of a metal material being of non-uniform shape along its length.

5. The beam of claim 4 wherein said shell is a hydra-formed metal section.

6. The beam of claim 5 wherein said beam comprises a vehicle control arm assembly.

7. The beam of claim 3 wherein said polymer is an expandable structural foam.

8. The beam of claim 3 wherein said polymer is a non-expandable structural foam.

9. The beam of claim 3 wherein said polymer is heat curable.

10. The beam of claim 3 wherein said polymer is ambient temperature curable.

11. A method of forming a three-dimensional laminate beam comprising the steps of inserting a pre-formed core insert within a hollow shell with the insert spaced from at least one inside wall of the shell and with the shell being of curved shape, pumping a reinforcing polymer in and around the core insert, and curing the polymer to cause the polymer to bond to the inside wall of the shell.

12. The method of claim 11 including pre-molding the core insert from a lightweight foam material.

13. The method of claim 12 wherein the shell is made of a hydra-formed metal section of non-uniform shape along its length.

14. The method of claim 12 wherein the resulting beam is a vehicle control arm assembly.

15. The method of claim 13 wherein the resulting beam is a vehicle component.

16. The method of claim 15 wherein the polymer is heat cured.

17. The method of claim 15 wherein the polymer expands upon curing.

18. The method of claim 15 wherein the polymer is cured at ambient temperatures.

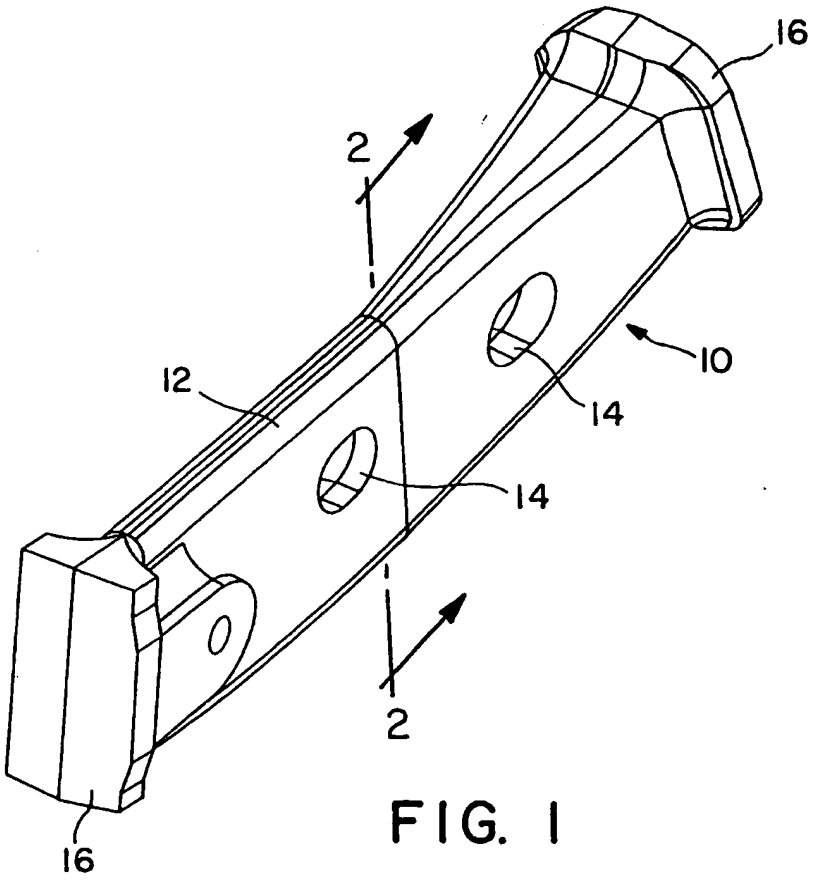


FIG. 1

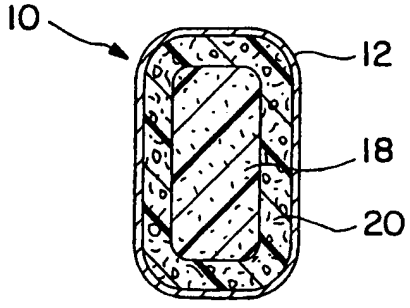


FIG. 2

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/18832

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :B62D 29/00
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X,P | US 5,806,919 A (DAVIES) 15 SEPTEMBER 1998 (15/09/98), SEE ENTIRE DOCUMENT, ESPECIALLY FIGURES 1-2. | 1-10 |
| X,P | US 5,866,052 A (MURAMATSU) 02 FEBRUARY 1999 (02/02/99), SEE ENTIRE DOCUMENT, ESPECIALLY FIGURE 6(C). | 1-10 |
| X | US 4,722,563 A (LOREN ET AL.) 02 FEBRUARY 1988 (02/02/88), SEE ENTIRE DOCUMENT, ESPECIALLY FIGURE 11. | 1-3, 7-12, 14-18 |
| X | US 5,575,526 A (WYCECH) 19 NOVEMBER 1996 (19/11/96), SEE ENTIRE DOCUMENT, ESPECIALLY FIGURE 11. | 1, 11, 13 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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# INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

29/897.2; 52/735.1, 731.6; 264/46.4, 46.5, 46.6; 296/187, 205, 901

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

29/897.1, 897.2, 897.35; 52/731.6, 735.1, 737.4, 738.1, 309.3, 309.4
309.5, 309.6, 309.7, 309.9, 309.14, 309.15, 309.16, 739.1; 264/46.4, 46.5, 46.6; 293/109, 120; 296/187, 205, 900, 901